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# DAMS IN PERMAFROST REGIONS

PLOTING V RAIONA VECHNOI MERZLOTY

by

F. P. Savarenskii

XEROX



TRANSLATION NO. 29

Arctic Construction and Frost Effects Laboratory  
U. S. Army Engineer Division, New England  
Waltham, Mass.

for

Office of the Chief of Engineers  
Civil Engineering Branch  
Engineering Division  
Military Construction

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**CORPS OF ENGINEERS, U. S. ARMY**

# **DAMS IN PERMAFROST REGIONS**

**PLOTING V RAIONA VECHNOI MERZLOTY**

by

**F. P. Savarenskii**

**Izbrannye Sochinennia, p 370-371 (1950)**

**(Moscow-Leningrad, Academy of Sciences)**

**Translated from the Russian by Orest Popovich**

**Massachusetts Institute of Technology**

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#### SUMMARY

Water reservoirs constructed over permafrost disrupt the natural thermal regime in the river bed, especially in the vicinity of the dam. Heat is accumulated by the water and is transmitted to the ground, causing thaw and water seepage. Frequently an ice crust is formed below the dam and may cause freezing and cracking of the dam. Examples are cited of damage to dams because of these factors.

## DAMS IN PERMAFROST REGIONS

F. P. Savarenskii

Unique conditions are encountered in the construction of dams in permanently frozen areas. First of all, it must be pointed out that rock layers may be decayed in zones of periodic freezing and thawing. This zone does not always correspond in thickness to the contemporaneous active layer of frozen areas, since the freezing regime does not remain unchanged with time, and in the (geological) times preceding ours the zone of periodic temperature fluctuation could have been considerably greater. Therefore it is not strange that even rocks as strong as granites have been converted in some river valleys into gravel 20 m deep. Thus, it is by no means always possible to find strong, undecayed rock at the desired depth.

A very important circumstance which has to be taken into account in the designing of dams on permafrost is the fact that by forming a water-reservoir on the river, we essentially disturb the thermal system in the river bed, as well as, partially, on the site of the dam. The accumulation of large masses of water in such areas, especially that entering the water-reservoir during the summer floods, leads to the accumulation of a considerable quantity of heat in the upper water. In winter this heat is lost both directly to the air and to the rock layers of the bottom of the river valley, which leads to the lowering of the upper boundary of permafrost both under the water-reservoir and under the dam. Thus, in a few years of a water reservoir's life (sometimes in a course of as few as 1-2 years), unfrozen ground appears under the water-reservoir at the former permafrost level, through which percolation of water from the reservoir begins. As a result of such percolation, springs can form under the dam, which freeze in winter producing ice layers hundreds of cubic meters in volume or more.

The body of the dam itself also becomes subjected to freezing. The concrete parts of the structure acquire cracks, while earth dams split up, forming cavities inside which are dangerous for the dam itself. In order to save the embankment of an earth dam in the White Sea-Baltic Sea canal from freezing, a peat insulation of the banks was successfully employed.

The extent of the difficulties which can be encountered for a water-reservoir can be judged by the example of the dam on the River Magdagach, which had a height of 5 m and a water capacity of 1,200,000 m<sup>3</sup>. The losses incurred in the percolation and ice formation constituted up to 90 per cent of the water content. The dam, with a concrete

diaphragm reaching down to the gravel-covered decayed porphyrite, became deformed to such an extent that it was ruptured at a high water level along a distance of 60 m. A second example represents a dam in Skovorodino, 8 m high, which was constructed in a river bed with the following composition of the upper layers: peat, 1 m; argillaceous soil with gravel and slime, 2.5 m; broken, and then compact, rock below.

The core of the dam was constructed to the rock (apparently decayed). The upper boundary of permafrost was 3 m from the surface before the construction work; the lower boundary was estimated at 90 m. After the dam was built, the boundary of the frozen state receded to 4 to 5 m from the surface, while under the dam the ground thawed and increased seepage began, forming springs and ice layers on the dry side, endangering the dam.